



# Value creation using minimal resources – A meta-synthesis of frugal innovation

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## ARTICLE INFO

### Keywords:

Frugal innovation  
Meta-synthesis  
Archetypes  
Resource constraints  
Bricolage  
Emerging economies

## ABSTRACT

The practice of frugal innovation (FI) has been garnering great research interest in recent years. Although initially focused on emerging economies, the idea is now more global, gaining adepts in developed economies. FI shows potential to effectively provide valuable products for underserved communities while sparing resources globally and contributing for social and environmental change. To reconcile a fragmented literature and provide a useful basis for evidence-based entrepreneurship and management, we conducted a meta-synthesis of 36 studies comprising 95 FI cases. We draw on our evidence-based analysis to present a phenomenological overview of FI through the sequential and interrelated relationships of the *who-why-where-how-what* of the practice. We then structure the evidence into a typology of archetypes, establishing the building blocks for future research to focus on the less investigated elements and explore additional interrelationships. Our conclusions contribute to the FI literature by providing a broader view of the concept, constituting a foundation for future theory and practice.

## 1. Introduction

The last few decades have witnessed the advent and development of an entrepreneurial wave from emerging countries, mostly Asian, as they transition to innovation-driven economies (Liu et al., 2019). The entrepreneurial agency in these contexts often rely on frugal innovation (FI), involving strategies based on “doing more with less for more” (Prabhu, 2017, p.1) i.e., creating value using fewer resources, for more people. Although the concept has been mainly associated with emerging economies, researchers now recognize that FI can also play an important role in developed countries (European Commission, 2016; Lim and Fujimoto, 2019). Recently, the development of FI has shown to be an important contributor in the tackling of the COVID-19 pandemic (Dahlke et al., 2021; Harris et al., 2020; Sarkar, 2021), further stimulating scholarly interest in FI.

FI has been studied under many different empirical settings and research fields, giving rise to a wide range of contributions. These go beyond extending the technology and innovation-related theory and practice, contributing also to fields such as social and environmental change (Brem et al., 2020; Hossain, 2021). Much like the fable of six blind men and the elephant that highlights the risks of narrow

perspectives on an intangible phenomenon, extant literature has tended to focus on specific dimensions of FI or elaborate on specific entrepreneurial contexts. This results in a highly fragmented field, thus hampering the opportunity for a better understanding of what constitutes FI, and which can support a theory of FI. With an increasing number of publications on FI in recent years, there is still no aggregation of their evidence-based findings, and the concept remains “fuzzy” (Weyrauch and Herstatt, 2016). Being a concept in expansion, there are a considerable number of theoretical and practical contributions which are called for. We believe that the FI stream of literature is now at a crossroads. The keen research and managerial interest in FI, and the increasing push by organizations worldwide to try “to deliver as good, with less” begs the need for a better understanding of the phenomenon. As developed country organizations seek to pursue frugal processes, FI can no longer be considered as a marginal phenomenon in developing countries.

Motivated by the aim of contributing towards the consolidation of the FI literature, namely via an empirical, evidence-based literature analysis, we chose to conduct a meta-synthesis. This method is based on exploratory and inductive research (Hoon, 2013), conducive to the integration of qualitative empirical data extracted from case studies

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<https://doi.org/10.1016/j.techfore.2022.121612>

Received 3 August 2021; Received in revised form 18 February 2022; Accepted 8 March 2022

Available online 18 March 2022

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(Habersang et al., 2019). Our sample was composed of 95 distinct cases drawn from research over 36 articles. Our evidence-based analysis is pivoted around the question of *what are the key dimensions involved in FI, and how do they interrelate*. From the analysis of the data extracted from the sampled case studies, we were able to identify common themes and distinctive patterns regarding the contexts, motivations, actors, processes, and outcomes of FI in an integrated framework.

Our synthesis combines integrative and generative approaches, considered a unique contribution that can emerge from reviews of extant literature (Torraco, 2005). We first reflectively reexamine and synthesize the existing repository of cases into the *who-why-where-how-what* framework (Buckley and Prashantham, 2016; Secundo et al., 2021) of FI which provides a broad, interrelated, and a holistic view of the concept based on empirical evidence of the practice. This provides a step forward in tackling the fragmented field by incorporating key FI dimensions in one study. We therefore address issues of generalizability and context-specificity which are often found in qualitative research (Lesner et al., 2018). Our study then articulates a typology through the identification of clusters of recurring patterns across the reexamined cases (Hoon, 2013; Rauch et al., 2014). Our typology of archetypes situates the actors' context, the target market and FI outcome, provides a means to analyze and organize global FI cases and contributes towards the theoretical development of the field. The typology establishes the building blocks for future research in the area, drawing special attention to the less investigated elements, and encouraging scholarship on their interrelationships with the remaining, to further enrich both the *who-why-where-how-what* framework and the typology itself. Both the synthetic and the generative elements create space for future researchers to complement them with further empirical insights, contributing to greater coherence and enrichment of the FI literature. Furthermore, by delving into the processes and outcomes of FI, we encourage entrepreneurs and managers worldwide to consider FI as an innovation strategy.

In what follows, we first provide a literature background on the concept of FI, focusing on the existing definitions and some gaps in the field (Section 2). In Section 3, our meta-synthesis methodology is described. In Section 4, the main findings are presented along the dimensions of *who-why-where-how-what*. We later discuss the results in Section 5, where we present a typology of archetypes. In the final section, the main conclusions and contributions of our work are outlined, along with the identification of its limitations and suggestions for future research directions.

## 2. Theoretical background

The concept of FI has been popular among practitioners and researchers on innovation in recent years. One of the first characterizations of FI was put forth by The Economist in 2010:

“There is more to this than simply cutting costs to the bone. Frugal products need to be tough and easy to use. (...) Frugal often also means being sparing in the use of raw materials and their impact on the environment. (...) Frugal innovation is not just about redesigning products; it involves rethinking entire production processes and business models.” (Economist, 2010).

Since then, a considerable amount of research effort has gone into the conceptualization of FI (e.g. Bhatti and Ventresca, 2012.; Hossain, 2018; Pisoni et al., 2018; Weyrauch and Herstatt, 2016). When searching for the term “frugal innovation\*” in the Web of Science database (without restrictions) as of December 2021, 332 results were yielded since 2011. A spike in recent research interest is clearly discernible, with around 49% of the research published between 2019 and 2021. Studies have explored the phenomenon in diverse fields such as management, business, entrepreneurship, engineering, development, and sustainability, revealing the concept's broad applicability and interest of researchers and practitioners.

As in any emerging field, there is still no consensus on the definition of FI, although there are common elements between the various definitions proposed in the literature. Overall, the concept has been commonly addressed to provide products or services in contexts of resource scarcity (material, financial or human) that perform well enough to satisfy the need of underserved customers at lower costs (Sarkar, 2021). In extant literature, various resource-scarce innovation types are often used interchangeably with FI, such as “good-enough innovation”, “resource-constrained innovation”, “inclusive innovation”, “Bottom of the pyramid (BOP) innovation”, “cost-innovation” and “grassroots innovation”. BOP has also emerged as a popular label, introduced by Prahalad and Hammond (2002) referring to the four billion people earning less than \$2000 per year, thus emphasizing the great market opportunity to develop products and services for the poor. Although the differences among these terms are often unclear, some efforts have been made in previous studies to reach a consensus on the topic (e.g. Klarin, 2019; Zeschky et al., 2014). Zeschky et al. (2014), for instance, argued that the terms differ from each other with respect to the original motivation, value propositions and value creation mechanisms. They distinguished between “cost-”, “good-enough-”, and FI, based on technical and market novelty, with FI being superior along with these parameters. These authors also defend that there is a cascade-type of dependency between the different resource-constrained innovations, in which the more novel ones capture all the traits of the less novel. Weyrauch and Herstatt (2016) conducted interviews with company managers, and researchers, aiming towards a universal criterion to define FI. They settled on the following three criteria to be simultaneously met in order to consider a product or service as an FI: *substantial cost reduction, concentration on core functionalities, and optimized performance level*.

While FI has been widely viewed as an innovation process arising in resource-scarce contexts, mainly in emerging economies, it has now been gaining increasing relevance in developed countries (Kroll and Gabriel, 2020; Pisoni et al., 2018 and references therein). The rising popularity of the practice of FI further creates the urgency to uniformize our understanding of the concept so it can be applied in both cases.

## 3. Methodology

An increasing number of qualitative case studies have been published in management and organization research, generating important contributions in different research areas (Hoon, 2013). Qualitative case studies provide “rich, contextualized, empirical descriptions of the dynamics of a single setting across multiple levels of analysis” (Habersang et al., 2019, p. 22). These are able to pursue research questions and provide specific information which cannot be fully revealed in quantitative studies. Moreover, case studies often explore under researched contexts and concepts, addressing complex and/or unique phenomena through an explorative orientation (Rauch et al., 2014). Nevertheless, qualitative case studies are often non-representative or do not provide enough basis for positivistic generalizations (Eisenhardt, 1989; Yin, 2009). With qualitative case studies tending to remain isolated scholarship, the potential to inform research, theory and practice through the accumulation and robust generalization of their meaningful contributions to a field becomes jeopardized (Habersang et al., 2019; Hoon, 2013; Leary and Walker, 2018). Qualitative evidence-based reviews, for instance synthesizing case studies, “can contribute significantly to the development of actionable knowledge” (Denyer and Tranfield, 2006, p. 222).

In management and related fields, quantitative meta-analyses have been preferred over qualitative methods of syntheses (Rauch, 2020). However, the former are not able to capture and integrate all the valuable inputs and contexts of individual qualitative studies (Hoon, 2013; Rauch, 2020). Syntheses of qualitative research, namely meta-syntheses, have now been widely applied in the medical and healthcare field (e.g. Beck, 2002.; Oga-Omenka et al., 2021; Reid et al., 2009). Although its

application in social sciences is less extensive (Dekker and Bekkers, 2015; Lee, 2010), there is a growing interest in qualitative and evidence-based methods in management and entrepreneurship literature, which are now finding a place in top-tier journals (Bansal and Corley, 2011; Comb et al., 2019; Rauch, 2020). Moreover, as FI empirical research is overwhelmingly qualitative, meta-synthesis emerges as an ideal method to identify common themes and build conceptual frameworks “which should, in conceptual terms, be greater than the sum of the parts” (Finlayson and Dixon, 2008, pp. 59-60)

We employ meta-synthesis, an exploratory and inductive research design that synthesizes primary qualitative case studies to make contributions beyond the original studies (Hoon, 2013). These contributions aim towards understanding and explaining phenomena and testing, refining or generating theory (Hoon, 2013; Walsh and Downe, 2005). Meta-synthesis aggregates and interprets the literature by using different techniques such as causal network technique, content analysis and cross-case analysis (Rauch, 2020). Meta-synthesis thus accounts “for all important similarities and differences in language, concepts, images, and other ideas around a target experience” (Sandelowski et al., 1997, p. 369), enabling the identification of common themes, and the construction of conceptual frameworks from the evidence uncovered in the literature (Carlson and Palmer, 2016). Our synthesis drawn from accumulated knowledge, is an ideal methodological tool and “hermeneutics”

when seeking to understand and explain a particular phenomenon (Walsh and Downe, 2005, p. 204). In novel or emerging areas of research, such evidence-based research “can connect research findings from various disparate sources in original ways” (Post et al., 2020, p. 352). Following the protocol suggestion by Hoon (2013), we followed eight main steps: (1) framing the research question; (2) locating relevant research; (3) inclusion criteria; (4) extracting and coding data; (5) analyzing on a case-specific level; (6) synthesizing on an across-study level; (7) building theory from meta-synthesis; (8) discussion of results (for further details on each step please see Appendix A). To “improve transparency, rigor, and transferability to other studies” (Carlson and Palmer, 2016, p.133) inherent to meta-syntheses, the criteria used to locate and select relevant literature and the processes conducted for their analysis are detailed in the sections below.

### 3.1. Study search and selection

After defining our research question, we initiated a search in the Social Sciences Citation Index of the Web of Science database with the keyword “frugal innov\*” in the topic (title, abstract, keywords), restricting the language to English and the document types to articles, which generated 124 results (December 2021). To ensure that our review did not exclude relevant articles, our search was further

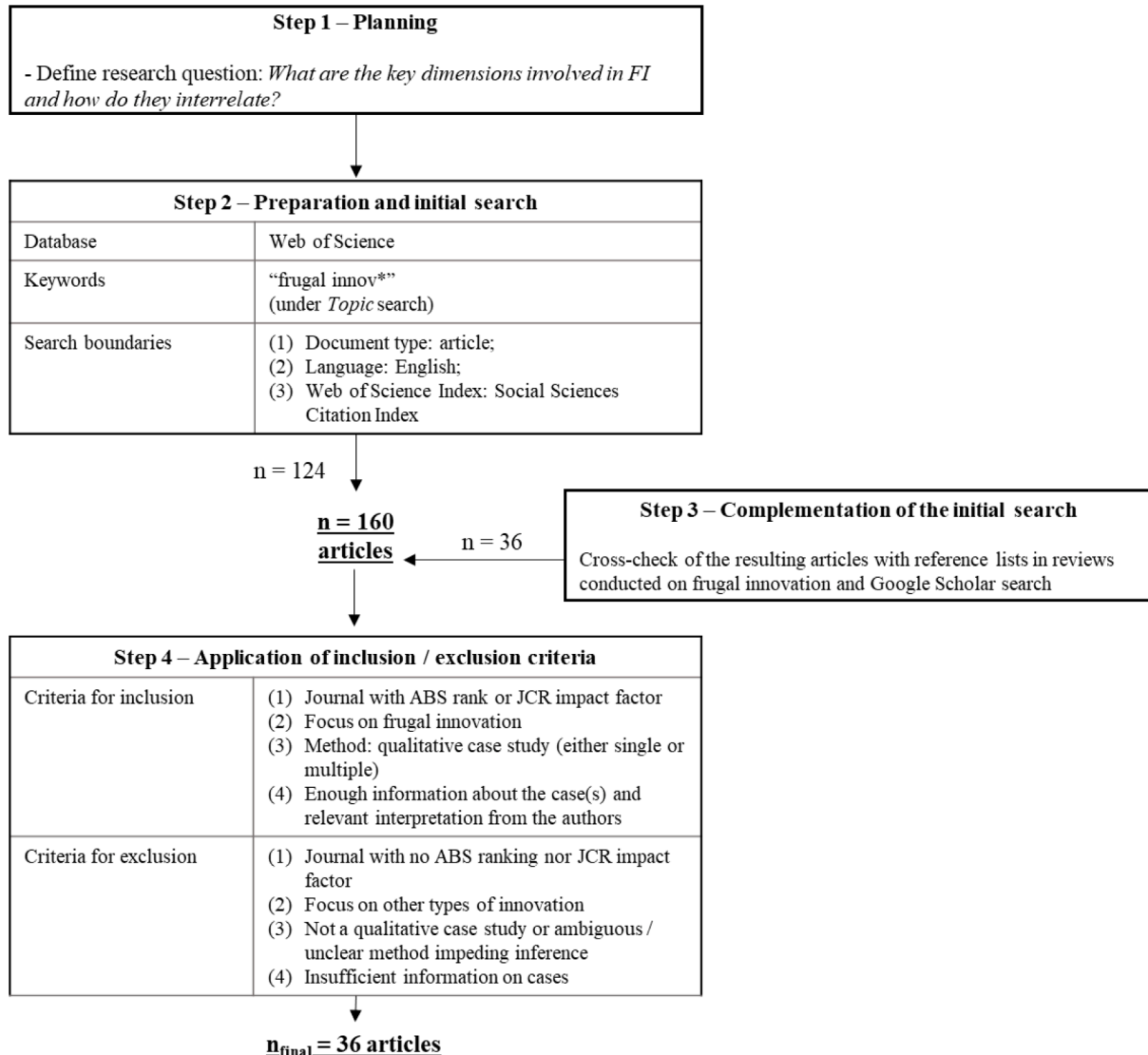


Fig. 1. Data selection process.

complemented by cross-checking the results list with the articles referenced in reviews on FI and Google Scholar searches (Hoon, 2013; Owalla et al., 2021). Consequently, 36 more articles were added to the initial sample, resulting in a total of 160 studies. Since a meta-synthesis “needs to incorporate a broad yet still manageable set of studies” (Hoon, 2013, p. 527), the initial sample was then screened according to inclusion and exclusion criteria. The first criterion regards a quality appraisal - articles were included if published in journals ranked in the ABS guide (2018) or indexed in Journal Citation Reports (JCR) (Grégoire and Cherchem, 2020). Secondly, false positives, i.e., irrelevant articles for the meta-synthesis such as those not focused on FI were excluded. The remaining articles were then categorized as quantitative, qualitative or illustrative studies (conceptual or review) (Carlson and Palmer, 2016). According to meta-synthesis guides, only qualitative case studies, either single or multiple, were included (Carlson and Palmer, 2016; Hoon, 2013). Any study where the method was not a case study or was not clear enough to be inferred was excluded (Hoon, 2013). Finally, articles were excluded when they did not provide enough empirical information about the cases in order to enable the understanding of the authors’ interpretation. The data selection process is summarized in Fig. 1. After applying these criteria, we ended up with 95 distinct FI cases, from a total of 36 studies (see Appendix B).

### 3.2. Data analysis

Both authors started by independently reading the full text in each article, and coding for its general details such as research question/objectives; methodology (sample size; sampling and data collection strategy); setting (cases identification; country; type of venture); key findings; contributions; limitations and future research. We then performed a within-case analysis of each individual article by coding in a line-by-line manner (Habersang et al., 2019). An inductive and open coding strategy was applied, which involved “breaking down, examining, comparing, conceptualizing, and categorizing data” (Strauss and Corbin, 1998, p. 57). This analysis was specially focused on the findings and discussion/contribution sections of the sampled articles as meta-synthesis involves the analysis not only of the empirical data retrieved for the elaboration of the original papers but also of the insights and interpretations of the researchers who elaborated them (Hoon, 2013). This strategy allowed to extract relevant data aiming to answer to our research question and contribute to define FI dimensions. After the analysis of each study, the process of cross-case and comparative analysis was performed. This involved the “deliberate search for similarities and differences between a target phenomenon and some other extra-study phenomenon (i.e., not addressed in the reports of studies reviewed) with an apparent resemblance to it” aiming to “clarify the defining and overlapping attributes of the target phenomenon” (Sandelowski and Barroso, 2007, p. 201). The iterative scrutiny of each case study and comparisons between them, enabled the identification of common themes and arrive at first-order concepts. This process was followed by axial coding which resulted in high-order, more abstract themes (second-order themes) (Locke 2001; Strauss and Corbin, 1998). The results from each author analysis were then jointly compared and re-examined to reach a final consensus on the final coding. Finally, second-order themes were aggregated into higher dimensions of FI (actors, motivations, setting/context, process, outcomes) (see Fig. 3). These higher dimensions were then considered as the “who”, “why”, “where”, “how” and “what”, respectively, to reveal an integrated framework. By answering these questions, we aim to provide a more complete and enhanced analysis of FI, as it has been done regarding other subjects (Buckley and Prashantham, 2016; Page and Vella-Brodrick, 2009; Prilleltensky, 2012; Secundo et al., 2021). The *who-why-where-how-what* framework contributes in providing conceptual clarity and a common language so that FI researchers engaged can comprehend each other and how their different yet related approaches relate. We then further extend our analysis to group the data into archetypes based

on the actors (who), the target market (where) and the innovation outcome (why + what). Archetypes bring the opportunity to cluster cases according to their similarities arising from the identified themes (Habersang et al., 2019).

## 4. Findings

### 4.1. Descriptive analysis

Before diving into the specific findings of our study, in this section we present an analysis of the broad characteristics of the selected case study articles. The 36 articles comprising our sample were published between 2011 and 2021, with a spike in the last two years, with over 55% of the articles being published in 2020 and 2021 (Table 1). This elucidates the accelerated pace of research interest and knowledge production in FI, specifically regarding qualitative empirical research, justifying the pertinence of conducting a synthesis of this body of work. The articles were published in 23 different journals (with a maximum of 3 articles per journal - Table 1) from different fields such as management, technology and sustainability. This analysis shows how scattered the FI empirical literature is and hints about the complexity and multidisciplinary of the FI concept.

Each article comprised either a single (39%) or multiple-case study (61%). It is important to point out that some cases are referenced in more than one study (see Appendix B), therefore the depth of information described on each case is variable. The majority of the 95 cases comprised in the 36 articles involved a specific product/service (69%). The remaining cases involved either a specific entrepreneur/venture (26%) or city/country (5%). The included cases were heterogeneous in terms of areas of innovation, some of the main being healthcare (26%), energy (19%) and transports (10%) (Fig. 2A). The 95 cases derived from innovations created by agents from both developed and developing countries (Fig. 2B). Although FI is gaining in popularity in the developed world, the majority of case studies are still about innovation in developing countries (68%), especially India (35%). It will be interesting to see how these proportions will change along the next years.

### 4.2. The *who-why-how-where-what* framework of FI

Our analysis follows the investigation along five broad themes of FI incidence: actors (who?); motivations (why?); context/setting (where?); process (how?); outcomes (what?), which emerged from the analysis of the studies (see Fig. 4). By answering these questions (Secundo et al., 2021), we provide a *who-why-how-where-what* framework based on five conceptual pillars. This is an integrated framework representing the multitude of actors involved in FI, their motivations and targets as well as the processes they engage into and resulting outcomes. Cost reduction and affordability was considered a more transversal theme of the framework (see Section 4.2.6). Fig. 3 illustrates, with direct quotes from the articles, the first-order concepts in which they were aggregated, as well as the second-order themes and emerging aggregate dimensions.

Fig. 4 below, encapsulates the *who-why-where-how-what* framework, tying our different findings, along these five dimensions.

In what follows below, we describe each identified dimension and underlying themes, offering a cohesive and intuitive narrative.

#### 4.2.1. Who - the actors developing FI

We found FIs being developed by a diverse range of actors, arising from different motivations and resource bases. FIs can arise from users’ own needs and direct observations in their environment, such as in the case of grassroots entrepreneurs and local ventures (Hossain, 2021; Pansera and Sarkar, 2016). Some agents are inherently attuned to social and environmental problems of the target environment and engage in FI as a response, such as social enterprises (Goyal, 2021; Kuo, 2017; Levänen et al., 2015; Molina-Maturano et al., 2020), non-profit organizations (NPOs) (Kuo, 2017; Lange et al., 2021), and universities / research

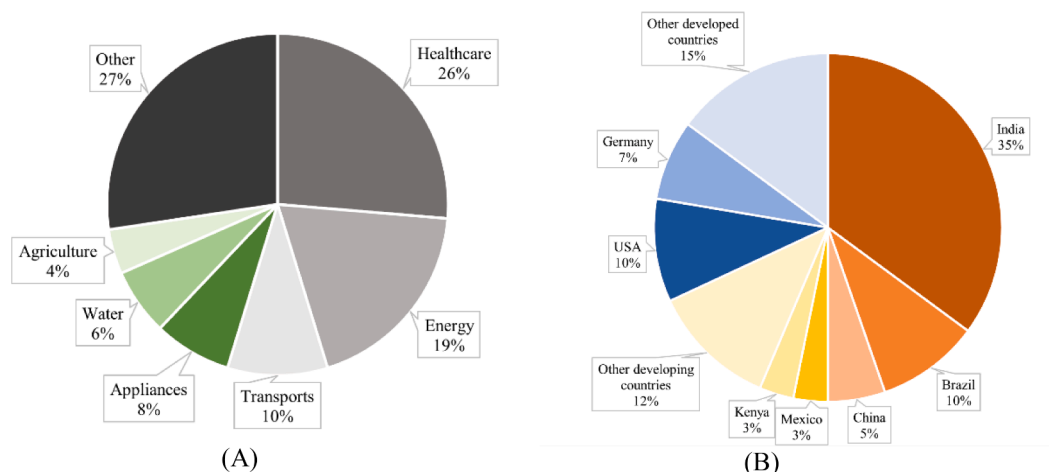


**Table 1**  
Included articles' information.

#	Authors	Year	Journal	Sample or cases <sup>1</sup>
<i>Product / Service cases</i>				
1	Zeschky et al.	2011	Research-Technology Management	5 cases from 4 countries: Switzerland (2), The Netherlands (1), USA (1) and Germany (1) and their China subsidiaries
2	Hossain et al.	2016	Technology in Society	4 cases from 2 countries: India (3) and USA (1)
3	Hyvärinen et al.	2016	Sustainability	1 case from Finland
4	Levänen et al.	2016	Sustainability	4 cases from India
5	Pansera & Sarkar	2016	Sustainability	4 cases from 2 countries: India (3); Bangladesh (1)
6	Bianchi et al.	2017	Technology in Society	2 cases by a Uruguayan hospital
7	Kuo	2017	Clean Technologies and Environmental Policy	4 cases from 4 countries: Philippines (1), China (1), India (1), Taiwan (1)
8	Winterhalter et al.	2017	Technovation	5 cases from 3 countries: India (3), USA (1) and The Netherlands (1)
9	Sharmelly & Ray	2018	Journal of General Management	1 South Korean MNC subsidiary in India
10	Brem et al.	2020	Journal of Cleaner Production	1 case from Brazil
11	Gandenberger et al.	2020	International Journal of Technology Management	4 cases from 3 countries: India (2), Germany (1) and Kenya (1)
12 <sup>2</sup>	Khan & Melkas	2020	International Journal of Technology Management	4 cases from 3 countries: India (2), USA (1) and Germany (1)
13	Molina-Maturano et al.	2020	Journal of Cleaner Production	2 cases from Mexico
14	Agarwal et al.	2021	IEEE Transactions on Engineering Management	1 case from USA-India and 1 from USA
15 <sup>2</sup>	Busch	2021	Cambridge Journal of Regions, Economy and Society	3 cases from Brazil
16	Corsini et al.	2021	R & D Management	2 cases from 2 countries: Italy (1) and India (1)
17	Goyal	2021	Organizational Dynamics	5 cases from 4 countries: India (2); USA (1); Philippines (1); Nigeria (1)
18	Hossain	2021	Technology in Society	3 cases from India
19	Hossain & Sarkar	2021	IEEE Transactions on Engineering Management	13 cases from 5 countries: India (8), Bangladesh (2), USA (1), UK (1), Canada (1)
20	Hossain et al.	2021	Management and Organization Review	3 cases from India
21	Khanal et al.	2021	Information Technology for Development	1 case from India
22	Lange et al.	2021	Journal of Small Business Management	11 cases from 6 countries: USA (3); Germany (3); South Africa (2); France (1); Kenya (1); Finland (1).
23	Vesci et al.	2021	R & D Management	1 case from Italy
24	Walden & Lie	2021	IEEE Transactions on Engineering Management	1 case from Australia
25	Weyrauch et al.	2021	IEEE Transactions on Engineering Management	1 case from USA
<i>Venture cases</i>				
26	Altmann & Engberg	2016	Research-Technology Management	1 case from Sweden
27	Bhatti et al.	2017	Health Affairs	5 cases from 5 countries: Mexico (1), India (1), Kenya (1), Singapore (1) and Brazil (1)
28	Lan & Liu	2017	International Journal of Technology, Policy and Management	1 case from China
29	Ananthram & Chan	2019	Asia Pacific Journal of Management	8 cases from India
30	Lu et al.	2020	International Journal of Production Economics	3 cases from China
31	Wimschneider et al.	2020	International Journal of Technology Management	6 cases from Brazil
32	Fischer et al.	2021	Journal of Knowledge Management	1 case from Brazil
<i>City / country cases</i>				
33	Annala et al.	2018	Journal of Cleaner Production	Case study of Ahmedabad, India on reverse osmosis water filters
34	Devi & Kumar	2018	European Journal of Development Research	Case study of Manipur, India on bamboo shoots processing
35	Peša	2018	European Journal of Development Research	Case study of Zitwe, Zambia on mobile money
36	Sarkar	2021	Government Information Quarterly	Case study of Kerala, India on combating a pandemic

<sup>1</sup> A total of 95 distinct cases are included in the studies (total count done after removing the overlapping cases between articles).

<sup>2</sup> These articles include cases from different types (product/service; venture; city/country). We presented it here only once to avoid repetition.



**Fig. 2.** Breakdown of articles by (A) areas of innovation and by (B) agents' country.

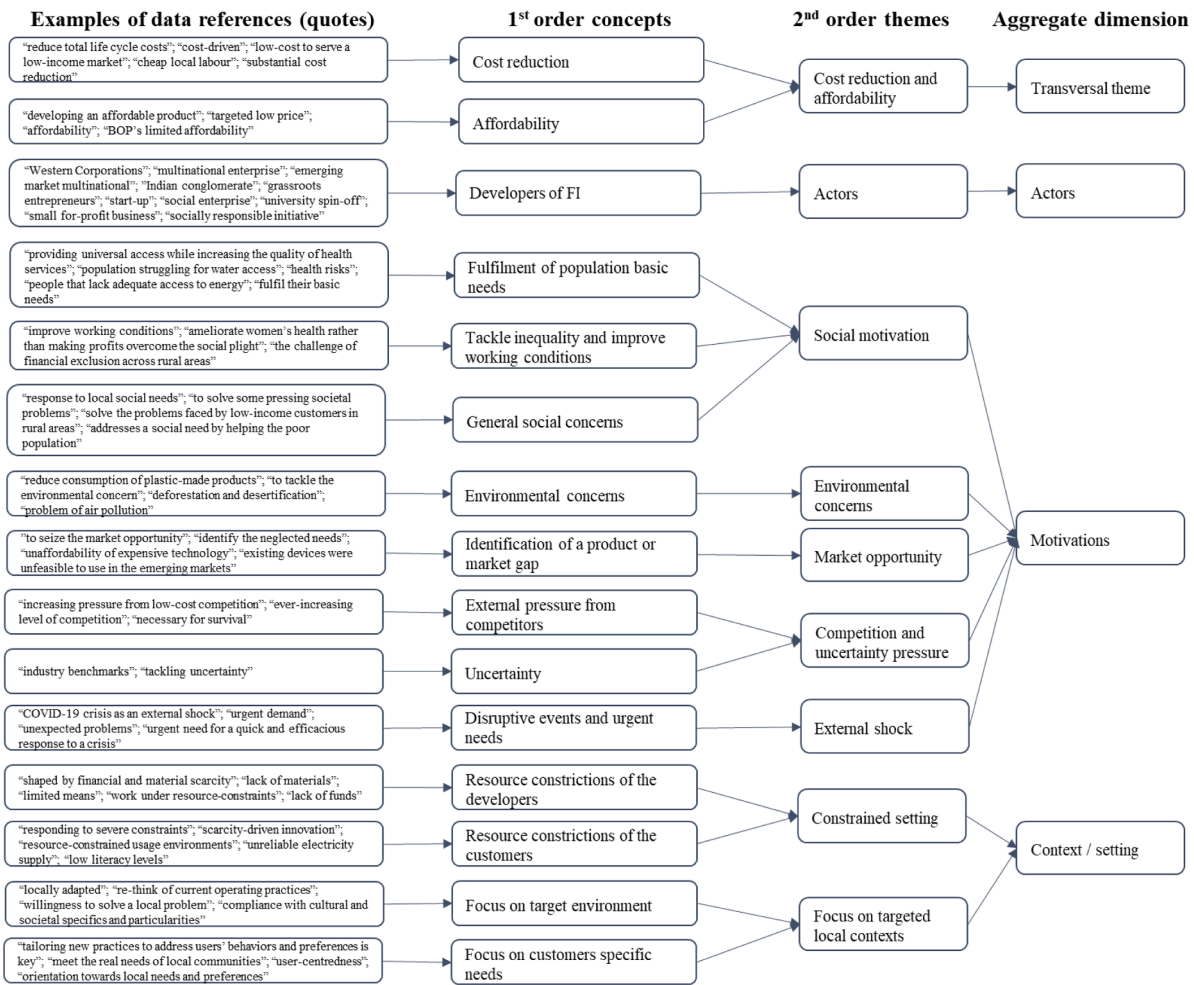


Fig. 3. Data structure.

institutes (Gandenberger et al., 2020; Walden and Lie, 2021).

Although FI has been mostly associated with bottom-up strategies and innovation from within emerging countries, it is increasingly evidenced that western multinational corporations (MNCs) have gained interested in the BOP market and engage in the development of these types of solutions, both in their home countries and in international subsidiaries located in the target market (Sharmelly and Ray, 2018; Winterhalter et al., 2017; Zeschky et al., 2011). MNCs from emerging countries have also been engaging in FI, such as the Indian MNC Tata with the Tata Nano car or Godrej with the ChotuKool refrigerator (Hossain et al., 2016; Kuo, 2017). Besides, supporting actors were found to be important for FI development. These supporting actors can either provide financial aid, technical support or local knowledge. These agents are also very diversified, ranging from friends and family of the inventor (Devi and Kumar, 2018; Hossain, 2021; Hossain and Sarkar, 2021), governmental supported initiatives for financial aid (Hossain and Sarkar, 2021; Sarkar, 2021; Lange et al., 2021), technology experts and universities for technical support (Lu et al., 2020; Walden and Lie, 2021), and local citizens for local knowledge (Altmann and Engberg, 2016; Hyvärinen et al., 2016).

4.2.2. Why - motivations in engaging in FI

**Social motivation:** Although not present in every single case, social concerns are the most frequently cited driver of FI emerging from our analysis. These social motivations are diverse and can be categorized into three main groups: (1) fulfillment of basic needs, (2) tackling inequality and improving working conditions and (3) other social

concerns. Frugal entrepreneurs who engage in FI reveal a genuine concern and are motivated to change the general poor living conditions of the underserved population (Goyal, 2021). They respond to this by providing services and products to fulfill their needs, which can be as basic as provision of safe water or electricity access (Levänen et al., 2015; Molina-Maturano et al., 2020). Exceptions to this are, for instance, MNCs which are driven by the market (commercial) opportunity or competition (see Sections "Market opportunity" and "Competition and uncertainty pressure") while targeting the BOP (Prahalad, 2012).

Women empowerment is one motivation to tackle inequality, which was the driving force for some of the cases we came across. Pansera and Sarkar (2016) discuss that the motivation of one grassroots entrepreneur who invented a sanitary pad making machine for rural communities was "not only to improve women's health but also create an ecosystem of women entrepreneurs all over rural India" (p.10). The fulfillment of basic needs – hygiene and health – was also a stimulus. Improvement of working conditions can further drive FI, especially when developed by embedded local entrepreneurs, who often have been personally affected by poor working conditions. For example, the development of a milking, or a cotton de-shelling machine, had the objective to optimize tasks which were done manually, which beside being very-time consuming, also caused the workers' extreme physical strain (Hossain, 2021; Hossain and Sarkar, 2021; Pansera and Sarkar, 2016). Another illustration is the development of a more ergonomic cart, which was created to ameliorate the working conditions of waste pickers who suffer from pain and other health issues due to their activity (Brem et al., 2020).

**Environmental concerns:** Environmental concerns can also be at the

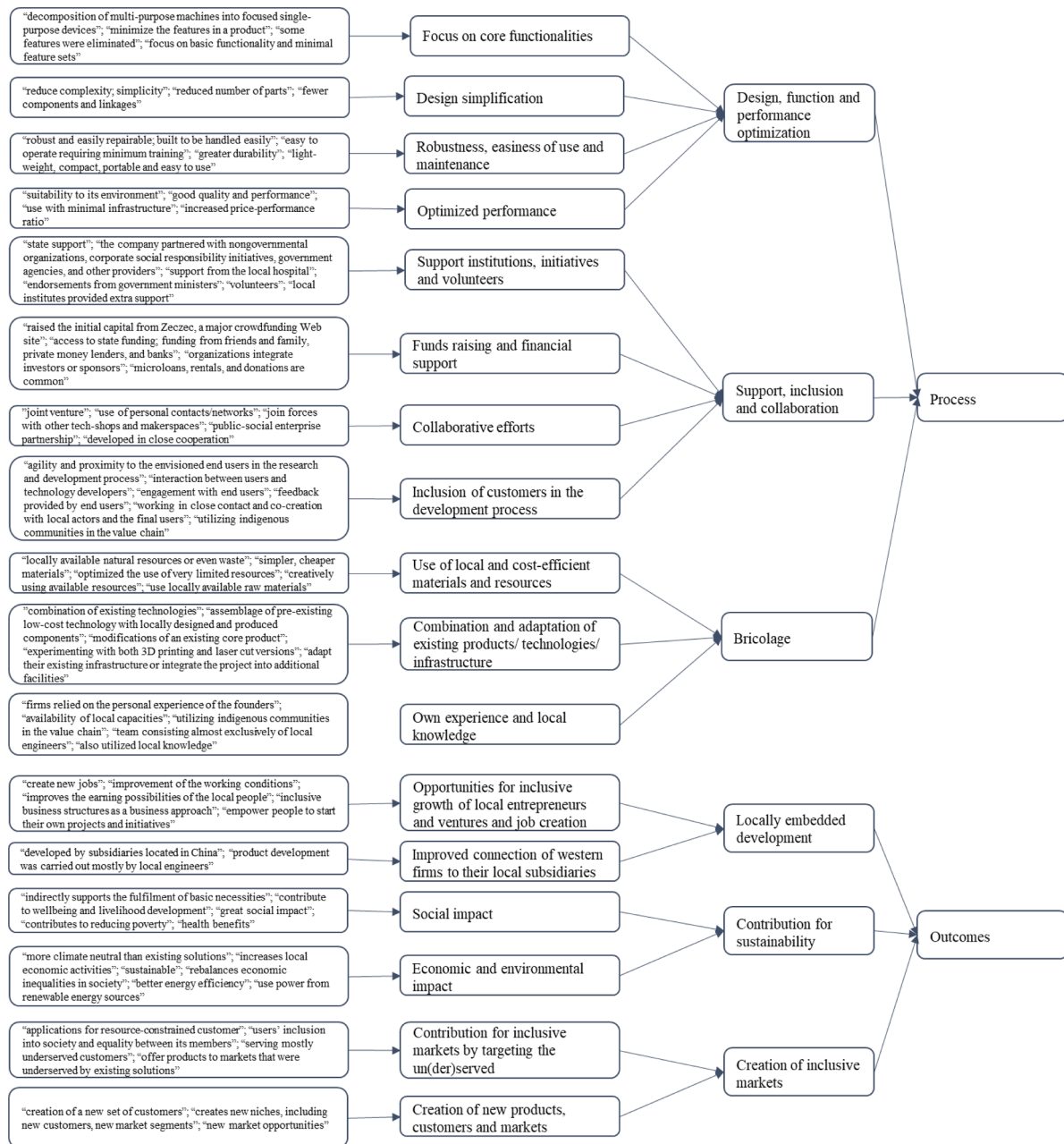


Fig. 3. (continued).

core of an entrepreneur’s motivations to innovate frugally. These range from tackling pollution, deforestation and cut plastic waste, to a more general concern for nature (Gandenberger et al., 2020; Kuo, 2017), giving rise to social enterprises. For instance, a couple of grassroots entrepreneurs in Taiwan founded their venture to develop 100% biodegradable products, such as a bamboo toothbrush, driven by their goal to reduce the consumption of plastic-made products (Kuo, 2017). Besides the health concerns of rickshaw pullers, the development of the solar-electrical rickshaw (Gandenberger et al., 2020), provided a pollution-free solution to reduce air pollution in Indian cities. The twin motivation of achieving both social and environmental benefits are common to other FI (Pansera and Sarkar, 2016; Gandenberger et al., 2020).

**Market opportunity:** Prahalad (2012) had earlier identified MNCs engaging in FI because of market opportunities to serve a new customer base, the poor and un(der)served at the BOP. The Tata Nano car was conceived to create “a new set of customers from those who own or are

able to own motorbikes” and the Vortex ATMs was created “to extend banking services to customers who were unserved” (Hossain et al., 2016, p. 135). Similarly, Hyundai India launched a small and affordable car model, the Eon, targeting Indian buyers who wished to purchase a car for the first time (Sharmelly and Ray, 2018). In another example, a major Indian home appliance producer identified a market opportunity to design an affordable and low-cost refrigerator for rural areas that resisted unreliable electric supply (Kuo, 2017). The portable ECG machine, made by General Electric (GE), was created only after the firm identified a market gap in the rural communities. On the one hand, GE verified that physicians in emerging countries were not able to afford existing technologies and on the other hand, there was a lack of appropriate alternatives for this market. This enabled the development of the frugal portable ECG machine (Khan and Melkas, 2020).

**Competition and uncertainty pressure:** Zeschky et al. (2011) found that western MNCs often engaged in FI due to pressure from low-cost emerging market competitors. This segment’s potential outweighed

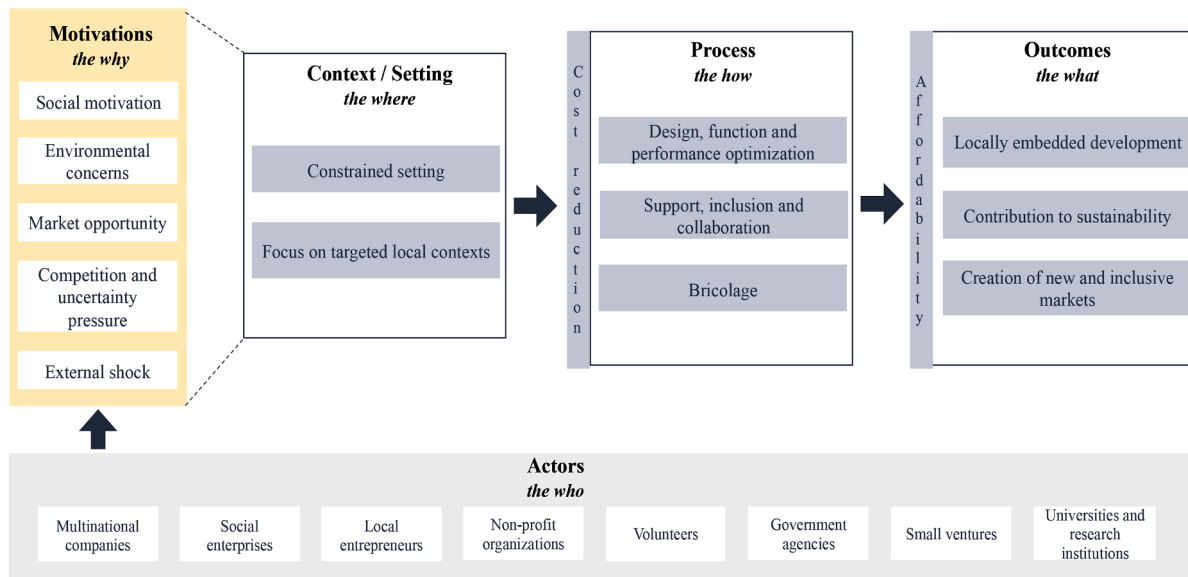


Fig. 4. Who-why-where-how-what framework of FI.

the concern that a new product “could cannibalize the company’s existing products in Western markets” (p. 40) Ananthram and Chan (2019). found the need to innovate frugally to be a survival response to government-initiated competition in the sector when studying eight Indian multinational companies Lu et al. (2020). discovered that Chinese low-speed electrical vehicles companies’ frugal strategies to be motivated by regional policy incentives.

**External shock:** Some FIs are motivated by emergent situations such as health crises, natural disasters, economic recessions, or other urgent situations. This has been recently observed in the case of the COVID-19 pandemic, where the shortage of medical and personal protection equipment emerged globally. Moreover, the development of tools to monitor and manage the spread of disease was also a priority. The urgency to acquire these materials and tackle the global pandemic was a motivation for the development of FI either by citizens, ventures, and governments, both in emerging and developed countries (Corsini et al., 2021; Sarkar, 2021; Vesci et al., 2021). Products such as valves for ventilators were rapidly developed by an Italian start-up in collaboration with hospitals and scuba dive masks manufacturers. Since the COVID-19 pandemic is a global emergency, the start-up decided to make their patent design freely available, so it could be manufactured elsewhere (Corsini et al., 2021; Vesci et al., 2021). Governments were also involved in FI during this pandemic event, as revealed by Sarkar (2021) in the case of Kerala in India. The Kerala State Government actively promoted FI and resorted to social media platforms to promote social distancing and supported several frugal initiatives to help manage and control and spread of the disease.

#### 4.2.3. Where – the developers and target context / setting

**Constrained setting:** Zeschky et al. (2011) observed that “what frugal innovations have in common is that they are all born of a situation of constraint and designed to meet the relatively basic needs of poorer consumers.” (p. 43). We found this observation to be mostly accurate. However, rather than for “poorer consumers”, we believe “un(der) served” to be more accurate, since this includes not only poor consumers but also price-sensitive customers. Even among the varied actors and motivations, contextual constraints and the needs of the un(der)served constitute a common context involving FI agency. While resource constraints were the most frequent, Agarwal et al. (2021) present another perspective, suggesting that constraints go beyond resources, including also market, infrastructure, environmental, user and manufacturing constraints, echoed by Hossain and Sarkar (2021). While these

constraints can impose a setback for entrepreneurial action, paradoxically they can also serve as an important driver of FI (Pansera and Sarkar, 2016; Agarwal et al., 2021). Frugal entrepreneurs are strongly driven and have shown to be able to surpass financial and material scarcity in order to execute their FI projects (Hossain and Sarkar, 2021; Kuo, 2017). Moreover, even when developers are in a resource abundant environment, it is essential to focus on the constraints of the target market so that they can properly define specific product requirements and functionalities (Agarwal et al., 2021).

Resource and other contextual constraints comprise those which are prevalent in most emerging countries and can also be imposed by specific situational contexts such as financial or health crises, and natural disasters, possibly affecting richer countries. Although most of the studies analyzed focused on the emerging economies as the target market, resource constraints can also occur in developed countries. Furthermore, in these specific cases, constraints go beyond the financial, material and human resources and time, becomes an important inhibitor (Vesci et al., 2021).

**Focus on targeted local contexts:** From our analysis, it became clear that proximity to the problem (Corsini et al., 2021) and the focus on the environment of final users determine an FI success or failure. For example, Winterhalter et al. (2017) found ventures developing medical devices and diagnostic tools after these encountered a lack of doctors and specialized lab personnel in the rural areas they were targeting. This led to fashioning their products to be used by technologically less skilled consumers. By focusing on the target customer needs and constraints, the entrepreneurs had gathered an understanding of which essential features to include during the development stage. Without this goal, frugal products are more likely to fail. Another example of the importance of understanding the target market is knowledge of the available infrastructures in place. For instance, erratic or no power supply is a reality in many rural contexts, being a constraint that needs to be considered when designing a frugal product, as low-cost products from developed countries would probably not be useful or appropriate in these contexts (Kuo, 2017). In similar instances of FI, we come across cases that rely on batteries, solar power or are somehow adapted to operate under fluctuating electrical supply or no electrical supply at all (Gandenberger et al., 2020; Hossain et al., 2016; Hossain, 2021; Khan and Melkas, 2020; Kuo, 2017; Pansera and Sarkar, 2016).

For embedded entrepreneurs, this focus and knowledge are usually facilitated since they are cognizant of the user environment themselves or through close relatives and local community (Hossain et al., 2021;



Pansera and Sarkar, 2016). MNCs and other bigger companies must find different ways to achieve so. Their focus on the targeted local context is revealed by different strategies (Zeschky et al., 2011): (1) the development of the product occurs in local subsidiaries by local engineers in China to guarantee that they “could effectively translate local requirements into final products” (p. 41); and (2) direct observation of the use of the products by local users in real context. Although deploying the development and production of FI by MNCs to subsidiaries is often beneficial, this may not always be the case. For instance, in a developed country setting, Altmann and Engberg (2016) observed that home-based R&D was more beneficial. The authors suggest that home-based development may be adequate when the market knowledge from emerging countries is based on objective data (e.g. electric power availability) and the technical capabilities needed for product development are difficult to transfer to emerging countries. On the other hand, R&D deployment would make sense in cases where market knowledge is only achievable by contact with locals (e.g., cultural and behavioral patterns) and technical capabilities are highly transferable (Altmann and Engberg, 2016). Nevertheless, in both situations, it is essential to focus on the environment, needs and desires of the target market.

#### 4.2.4. Process – how are FIs being developed?

*Design, function, and performance optimization:* Frugal products are not simply low-cost and lower quality adaptations of Western products (Economist, 2010; Kuo, 2017; Zeschky et al., 2011) or cutting to the bone. Instead, “they are the result of a unique value architecture that is grounded in the drive to meet basic requirements at the lowest possible cost”, therefore aiming at optimizing the cost-performance value (Zeschky et al., 2011, p. 42), while accounting for constraints such as environmental (e.g., incomplete infrastructure) and others (Kuo, 2017). FI can often involve rethinking of the entire production processes and business models (Economist, 2010).

Focusing on core functionalities enables cost reduction, product use simplification and performance optimization. Different architectural approaches can be used to ensure a good performance, focusing on the essential features for the user. Winterhalter et al. (2017) have observed and highlighted the following two in their study: (1) “the transfer of a new but established technology from another context” and (2) “the decomposition of multipurpose machines into focused single-purpose devices” (p. 8). These processes result in products which “have fewer features and/or performance compared to existing Western standards but at the same time feature characteristics, which are superior to Western products” (p. 9). Overall, their performance is optimized for the environment in which they are intended to be used. Another common way to focus on core functionalities and lean designs is to reduce the number of components used in the standard western alternatives, i.e. defeating (Kumar and Puranam, 2012). For instance, to build a frugal refrigerator in India, developers reduced the number of components from 200 to 20 parts (Kuo, 2017).

Simplicity, robustness, and ease of use are important characteristics of FI. Since target users are often less technologically adept consumers, it is important for developers of successful FI to keep the product simple to use. For instance, one entrepreneur emphasized regarding his frugal sanitary pad making machine (Pansera and Sarkar, 2016): “They are also very simple to use, and even a very young girl with just a bit of training could use” (p. 11). Durability and robustness are also important as many of these FIs, such as portable medical devices, are targeted to be used and sometimes travel through remote, rural and harsh areas (Winterhalter et al., 2017). Another important strategy to optimize the performance of frugal products is to develop them in a way they can be used in places where there is erratic or no electrical supply, which has been widely applied in appliances such as cookers or refrigerators (Kuo, 2017; Hossain et al., 2016; Hossain and Sarkar, 2021).

In resource scarce environments where money is tight and technical / technological expertise is low, it is also important to reduce maintenance costs and complexity. This is considered during the development

process of FIs (Annala et al., 2018; Hossain, 2021; Wimschneider et al., 2020), and can be achieved, for instance, by reducing the complexity of the electronics used (Pansera and Sarkar, 2016), often complemented with training (Busch, 2021; Lange et al., 2021). While some researchers defend that for FIs to maintain simplicity, they must use low-end technologies, we find that this is not always the case. Products may incorporate high-end technologies, associated with simple architectures, and still be a successful FI. Lower costs are maintained by using already developed technologies and cutting out functions which are considered a nice to have rather than essential (Bianchi et al., 2017; Kuo, 2017). Overall, we find FIs to be products with optimal level of performance, reliable, of simple design and robust. Some level of flexibility for adaptation to different environments and resources was also suggested by some studies as an important FI feature (Corsini et al., 2021; Molina-Maturano et al., 2020). Our observations are in line with Le Bas’ (2020) view of frugality as a new technological paradigm, i.e., although FI may involve both low-end and high-end technologies, there is a common underlying thought process on the way they are used. Le Bas (2020) elaborates that in frugality, despite the type of technology used, the focus is on maintaining a certain quality standard and core functionalities with fewer elements in order to cut costs, simplify manufacturing and reach just the right performance for the target market, which we have observed is our sample.

*Support, inclusion, and collaboration:* Support, inclusion, and collaboration emerge as an important ternary feature in the FI process. This is true regardless of whether the process is undertaken by MNCs, embedded local ventures and entrepreneurs, or others, albeit the types of support and collaboration differ accordingly. Of the five healthcare related innovations they studied, Bhatti et al. (2017) found that they were all “able to take root and eventually be scaled up in part because of critical connections to mentors, implementation partners, and start-up financing” (p. 1916). Positive endorsements from highly influential agencies, such as the government, can also improve the success of an FI, by building up the reputation of the developers (Corsini et al., 2021; Hossain, 2021).

Finding financial support remains a challenge, especially when the developers are locally embedded poor entrepreneurs or small local ventures. These entrepreneurs do not usually have the financial means to develop their products and create their ventures, usually borrowing to kick-start their projects. Money can come from venture support associations, the state, family and friends, banks, and other sources. For western ventures, this path is simpler since there is easier access to alternative funding sources such as venture capital, crowdfunding and innovation hubs (Hossain, 2021; Hossain and Sarkar, 2021).

Another collaboration strategy which we have found to be common in the FI process is engagement with end users. Feedback from users has proved to be very helpful to develop products which are in line with actual consumer needs. This interaction with users was shown in several studies in diverse contexts, ranging from surveys to a more active involvement of local users in the development process (Bianchi et al., 2017; Brem et al., 2020; Kuo, 2017; Vesci et al., 2021). Furthermore, this proximity with the consumer community and their involvement in the process also prevents the low-adoption rates (Molina-Maturano et al., 2020).

Collaborations can become even more crucial in cases where time is a constraint, such as in the case of a health crisis. For instance, Corsini et al. (2021) noted how a doctor, anticipating the shortage of masks for assisted breathing, wondered if a scuba diving mask could be adapted for the purpose. A collaboration was rapidly established with a scuba diving mask producer, which allowed the rapid development of the product. Although the product standards were inferior comparing with the usual applied standards, it was good-enough and had adequate performance. Another collaborative strategy during the pandemic was the creation of non-profit open sources where makers made their technical designs and files public so that other people could replicate their products (Corsini et al., 2021; Vesci et al., 2021). Partnerships in the

form of collaborative dialogues between the entrepreneurs and the local government were found to be a critical dimension in Kerala's contagion control efforts (Sarkar, 2021).

Winterhalter et al. (2017) noted that western high-tech firms felt the need to partner with local firms specialized in low-cost production and non-governmental organizations (NGOs) with distribution network know-how. On the one hand because this reduced costs, while on the other because they lacked the low-cost development capability needed to devise a frugal product or lacked the network knowledge. Therefore, even when the developers have the financial means to develop FIs, collaborations of this kind may be essential.

Overall, support and collaboration emerged as common themes from the studies, ranging from endorsements, donations, and government support (Corsini et al., 2021; Sarkar, 2021; Kuo, 2017) to more complex collaborative networks aiming to create solutions with social value (Corsini et al., 2021; Molina-Maturano et al., 2020; Vescei et al., 2021). Partnerships with governmental and non-governmental agencies and social initiatives can also be important to allow FIs to be provided to the underserved for lower prices or even for free (Agarwal et al., 2021). Although facing their own challenges, universities and research facilities can also foster FI and be important partners for product development (Fischer et al., 2020; Walden and Lie, 2021). Nevertheless, it is still important to point out that, in general, the establishment of partnerships may be a challenge and may not be effective when the objectives between partners are misaligned (Hossain and Sarkar, 2021).

**Bricolage:** The evidence points to the use of bricolage involved in "making do by applying combinations of the resources at hand to new problems and opportunities" (Baker and Nelson, 2005, p. 353), as an important underlying process in the development of FIs. Bricolage employs local and cost-efficient materials, and the combination and adaptation of existing products/technologies/infrastructures while leveraging own experience and local knowledge (Sarkar, 2018). These were common sub-themes arising from our analysis of the FI development process. In their insights, some authors have explicitly referenced the bricolage concept as a part of the FI process (Kuo, 2017; Pansera and Sarkar, 2016). The use of bricolage was carried out by different types of actors, from grassroots entrepreneurs (Kuo, 2017; Pansera and Sarkar, 2016) to emerging and western MNCs (Zeschky et al., 2011). Even when bricolage was not explicitly highlighted, almost every article analyzed has pointed out the use of easily available material or "the resources at hand" to develop FI, such as: "made from raw materials available in India" (Hossain et al., 2016, p.135); or "all the case study companies also fully utilized natural or low-cost/free resources available locally" (Kuo, 2017, p.1117). Many authors referred to the adaptation of existing (1) products: "an attachment that could be added to the scuba mask to repurpose it into a fully functioning CPAP mask" (Corsini et al., 2021, p. 201); (2) technologies: "based on established technologies that were tailored to the specific customer needs" (Winterhalter et al., 2017, p.8); "Thermoelectric cooling is not new—the technology has been extensively used, mainly in developed countries, to cool down high-end CPUs in computers, but has never been used to replace compressors to become a low-cost cooling engine for fridges" (Kuo, 2017, p. 1115) or (3) infrastructures: "use of existing infrastructure" (Molina-Maturano et al., 2020). Although the use of local resources was a prime process in most cases, the reliance on imported resources and raw materials was still important in some (e.g. Hossain and Sarkar, 2021.). Leveraging local knowledge to understand the needs and limitations of the consumers and the market, was a key factor in developing many FIs (Wimschneider et al., 2020; Winterhalter et al., 2017; Zeschky et al., 2011). The use of own knowledge and experience, either highly technical or self-taught skills also proved to be useful for the FI process (Pansera and Sarkar, 2016; Winterhalter et al., 2017).

#### 4.2.5. What – outcomes of FIs

**Locally embedded development:** FIs contribute to local development by creating opportunities for inclusive growth of local entrepreneurs and

ventures. FI development among local entrepreneurs frequently led to the creation of local ventures which generated employment opportunities for local people (Hossain, 2021; Pansera and Sarkar, 2016), contributing towards the locally embedded development of resource-constrained regions. Lange et al. (2021) studied the relationship between FI and inclusive business in a multi-case study of 11 FIs implemented in the African context, encountering heterogeneous ways of FI to contribute towards inclusive business. All cases revealed a strong focus on training local people (knowledge transfer), in turn stimulating entrepreneurial activity for locals, enabling them to pursue their own projects. In some, the role of empowerment is more direct via the creation of jobs for the locals or the implementation of self-employment structures, delegating "responsibility to the target group while simultaneously enabling people to earn more money with this business model" (Lange et al., 2021, p. 24). In other cases, the role is more indirect and is created by the product itself. For instance, the solar-powered rickshaw has a direct effect on sustainability by reducing pollution (see Section "Contributions towards sustainability"), while it has an indirect outcome regarding locally embedded development as it allows rickshaw pullers to run longer distances and earn more money (Gandenberger et al., 2020).

In their study, Zeschky et al. (2011) found that all 5 western MNC studied chose to deploy the development of the frugal products in their China subsidiaries, albeit with different degrees of autonomy. While the reasons for this deployment were mainly for cost advantage, "understanding the local environment and user behavior was vital to product success" (p.41). Moreover, the development teams consisted "almost exclusively of local engineers", and these organizational strategies seem to have contributed to local development by job creation and empowering of local workers in the subsidiaries.

Nevertheless, some caution should be taken when generalizing the long-term positive effects of FI, since in some cases, although enabling job creation and promoting entrepreneurship, it can also partially contribute towards socio-economic inequalities. One example is the case of mobile money in Kitwe studied by Peša (2017) who observed inequalities on work conditions between agents and tellers.

**Contributions towards sustainability:** Frugal products and services often satisfy basic needs, such as food, healthcare, water, and energy (Levänen et al., 2015; Winterhalter et al., 2017). FI thus contribute to the triple aspects of sustainability: social, environmental, and economic, as explored in a considerable number of studies in our sample (see Ganderberger and Walz, 2020; Hossain et al., 2021; Levänen et al., 2015; Molina-Maturano et al., 2020; Pansera and Sarkar, 2016).

The social outcomes of FI are diversified. For instance, the Narayana Hrudayalaya hospitals in India provide "world-class yet cost-effective cardiac care by applying the principles of lean manufacturing and mass production" (Khan and Melkas, 2020, p.168), enabling poor people to have access to quality healthcare, operated for free or at very low price while high profit margins are still obtained from richer patients in the hospital. Winterhalter et al. (2017) found FIs in MedTech to contribute towards increased efficiencies of the healthcare systems in rural areas, allowing, for instance, basic examinations to be conducted outside hospitals by personnel with basic training. These examples promote social sustainability by providing high-quality healthcare services for the un(der)served, contributing towards an improved quality of life. Another example is the solar-powered Vortex ATMs (Khan and Melkas, 2020) which promote social inclusion by providing rural and semi-urban population, while still illiterate, with easy access to a financial service. The creation of new jobs and community empowerment, discussed earlier regarding local development, were important contributors to reduced poverty.

There are several cases of frugal renewable energy equipment products, based upon solar or wind energy (for example, Levänen et al., 2015; Pansera and Sarkar, 2016). These were usually developed by social enterprises and NGOs and contribute directly towards environmental sustainability, providing alternatives to conventional, more

polluting non-renewable options (Levänen et al., 2015; Busch, 2021). They also contribute to social sustainability by providing energy to the poor or regions with erratic or poor supply at all, indirectly improving both living and working conditions and quality of life in general (Kuo, 2017; Levänen et al., 2015). For instance, the development and implementation of frugal solar photovoltaic microgrids in remote locations allowed indigenous communities to have continuous energy access while previously this was limited to about 4 hours a day, reducing the use and dependence on volatile fuel shipments and external maintenance (Busch, 2021). Another way to contribute towards sustainability is from the FIs tending to be more energy efficient than conventional alternatives (Khan and Melkas, 2020). Moreover, using locally available materials (see Section "Bricolage") also contributes towards sustainability in at least two different ways: first, the emissions generated by transportation are reduced, and second, the local ecosystem is strengthened (Hossain et al., 2021).

*Creation of new markets:* FI contributes towards the establishment of inclusive markets where the un(der)served become, and are seen as proper customers instead of people in need of humanitarian help (Winterhalter et al., 2017). By providing affordable and viable solutions for a "niche market" (Hossain, 2021, p. 4), FI enables poor consumers to acquire products previously unaffordable, and suitable for them and their environment. The Tata Nano served a new market segment, enabling people who used to only be able to afford motorbikes (Hossain et al., 2016). Other examples show that new market segments can be created in rural areas by delivering technologies, for instance ultrasound technology, which were previously bound to specific infrastructure and specialized staff (Winterhalter et al., 2017). Hence, we see that FI has the capacity to create new customer and market segments when a new value or application is provided (Hossain, 2021; Winterhalter et al., 2017). Nevertheless, it is important to note that beside all their advantages such as low cost, some FIs are likely to remain unachievable for "the poorest of the poor" (p. 8) if additional support, such as infrastructural or financial is not provided (Hyvärinen et al., 2016).

#### 4.2.6. Cost reduction and affordability – a transversal theme

Cost minimization and affordability are transversal strategies associated with FI throughout the cases. Cost reduction can be achieved in diverse forms, and stages of development. Cost savings can occur in the production phase by deploying production in emerging countries, resorting to local workers and by using local, cheap and cost-efficient raw materials. Focusing on core functionalities and reducing the number of components is another important source of cost reduction. Transportation costs and logistics also reduce when applying the above strategies. Furthermore, resorting to local people and already established networks for marketing and sales can facilitate commercialization and cut costs (Bhatti et al., 2017; Hossain, 2021; Hyvärinen et al., 2016; Pansera and Sarkar, 2016; Winterhalter et al., 2017; Zeschky et al., 2011).

Cost reduction occurs as the product must be affordable in order to serve the un(der)served. Affordability is then one of the main value propositions for FI customers (Winterhalter et al., 2017). Still, there is no specific price reduction target to classify a product as frugal. For instance, the Lullaby Warmer developed by GE sells for 20% of the price of their baby warmer for developed countries (Agarwal et al., 2021). Another example is that of a new cart for waste pickers, 60% cheaper than the previously used solution (Brem et al., 2020). Jaipur foot artificial limbs were made available for a value as low as 3\$ each comparing to alternatives costing 2500\$ upwards (Goyal, 2021). Affordability is not the only factor to be considered by entrepreneurs when developing an FI, since this is often connected with other challenges such as weak infrastructure (Kuo, 2017) or low literacy levels (Agarwal et al., 2021). Therefore, a focus on other specific constraints of the target market is an essential strategic step in FI, as it became clear from across the reported findings.

In their comparison of the Brazilian and Asian BOP markets,

Wimschneider et al. (2020) emphasized that resource-constrained / BOP customers are also not equal across the globe, therefore, some may prioritize the value for money over the lowest-price option, especially when the added price is associated with increased quality or status.

## 5. Discussion

Our study employed a qualitative meta-synthesis of 95 cases of FI contained in 36 articles. Based on our analysis and the evidence uncovered from the studies, we articulate a typology of archetypes by identifying the recurring patterns across the reexamined cases. To move FI research forward, we draw on our evidence-based analysis to present a phenomenological overview of FI, that emphasizes the sequential, and interrelated relationships of "who-why-how-where-what" of the practice. The typology of archetypes captures this dynamic and presents the overarching nature of the phenomenon.

Our typology (Fig. 5) is presented along three major dimensions of analysis: actors' context, target market and FI outcome (commercial or social). By choosing these main dimensions, we can construct a set of structures reflecting a holistic perspective and a single interpretive scheme of the increasingly international phenomenon of FI. The archetypes also capture the diversity through typologies (Greenwood and Hinings, 1993; Lammers, 1978; Weber, 1947) of FI.

The rising interest in practicing FI is reflected in the wide range of actors enacting entrepreneurial action to develop FIs worldwide. They enact in a resource abundant environment, as in the case of some MNCs, or in resource-scarce environments, such as poor entrepreneurs and small ventures. Nevertheless, since cost reduction and affordability is a transversal characteristic of FI, even actors (or developers) with less or no resource restrictions tend to employ resources sparing and/or other cost-efficient strategies in order to achieve products or services which are affordable for the underserved consumers from both developing and developed countries. We also observed that, despite a wide range of motivations, FIs usually have two types of outcomes: either a market-based commercial outcome or a more socially orientated outcome. Below, we discuss the main findings which characterize each of the eight archetypes we presented.

### 5.1. FI archetypes' description

#### 5.1.1. Commercial A-E

In general, less resource constrained actors, such as MNCs or larger firms, tend to have a more market orientated view. FI products are more commonly targeted towards emerging countries, and we find many cases of more resource-abundant actors targeting these, inspired by the BOP hypothesis (Prahalad, 2012). Examples include MNCs both from developed countries such as GE, Phillips or Logitech as studied by Zeschky et al. (2011), but also from emerging economies such as the Indian MNCs Tata (Hossain et al., 2016) or Airtel (Peša, 2017). Usually, these ventures identify the opportunity to establish or expand their business and products to the BOP or poorer populations, since there is a high growth potential for these to become new customers if appropriate solutions are offered. Although business models may differ, we discover that relying on locals to obtain knowledge about the target market and establishing partnerships with local business, are common strategies undertaken by these ventures. Moreover, various foreign MNC have chosen to establish subsidiaries in the target market to reinforce these actions. This was the case of GE for the development of a portable ultrasound machine, or Logitech to develop a computer mouse (Zeschky et al., 2011). In these situations, subsidiaries' autonomy and empowerment was essential for the development of FI. The subsidiaries external relational embeddedness has also shown to be essential for the development of local innovations elsewhere (Isaac et al., 2019).

#### 5.1.2. Social A-E

Cases where actors from resource-abundant contexts engage in FI

		Actors context		Resource Abundancy		Resource Scarcity	
		Target market		Emerging country	Developed country	Emerging country	Developed country
FI outcome	Commercial	<b>Commercial A-E</b> - Motivated by the identification of underserved markets - Usually rely on locals to gain knowledge of the environment - Connection with local subsidiaries	<b>Commercial A-D</b> - Adoption of frugal mindset over traditional innovation processes - Can also be reverse innovations (out of scope)	<b>Commercial S-E</b> - Not observed as a primary goal/outcome - Commercial outcome is secondary to the social one	<b>Commercial S-D</b> - Not observed - If existent, is it considered reverse innovation? (out of scope)		
	Social	<b>Social A-E</b> - Based on solidarity on health and environmental concerns, among others	<b>Social A-D</b> - Motivated by external shocks (e.g. pandemics or natural disasters)	<b>Social S-E</b> - Motivated by concerns such as working conditions and the fulfilment of basic needs - Usually arises from struggles of the own developer's environment	<b>Social S-D</b> - Not observed - If existent, is it considered reverse innovation? (out of scope)		

Fig. 5. Archetype framework based on the actors' context, the target market and the FI outcome. Abbreviations: A – resource abundance; S – resource scarcity; E – emerging country; D – developed country.

with social motivations and outcomes are rarer. Although many of the profitable FI indeed provide an improvement on the quality of life of the users and can even promote job creation in developing countries (for instance, when local subsidiaries are involved), this is usually a “side effect” and not the prime motivator. Still, examples were observed, such as those developed by non-profit or social enterprises whose both motivation and outcome are essentially social. Such is the case of the US non-profit organization which provides 3D-printed limbs in South Sudan (Lange et al., 2021).

5.1.3. Commercial A-D

The development of FIs from resource-abundant developers to developed countries are not so common, either with commercial or social aims. Although evidence was scarce, we found some evidence of increasing interest of less resource scarce ventures to develop FI for developed countries, with a commercial purpose, such as an US engineering firm developing a frugal torque limiter (Weyrauch et al., 2021), or Mettler Toledo developing a basic weighing scale (Zeschky et al., 2011). Still, ex-post evidence is still lacking on the acceptance and effects of these and other innovations in these contexts.

In some cases, ventures decide to engage in FI for developed countries only after being successful in developing countries (Commercial A-L), which was the case with the Siemens tomography scanner and Phillips patient monitoring system (Zeschky et al., 2011). The later cases are examples of “reverse innovation” (Immelt et al., 2009), suggesting potentially disruptive processes involving “the case where an innovation is adopted first in poor (emerging) economies before “trickling up” to rich countries” (Govindarajan and Ramamurti, 2011, p.191). Another example is the GE ultrasound machine which was first developed for the Chinese market but was later found to be competent to be marketed in developed countries such as the USA, where it is used in emergency units and ambulances, for instance (Hossain et al., 2016; Zeschky et al., 2011).

5.1.4. Social A-D

Hereto, cases were scarce regarding FIs developed by resource abundant actors to developed country markets, with social outcome. Nevertheless, we have recently observed that these can arise from external shocks such as health crises or natural disasters, providing solutions with mostly social outcomes, as we have observed with the Italian 3D-printed valves to be used in ventilators' masks during the COVID-19 pandemic (Corsini et al., 2021; Vesci et al., 2021). It is still necessary to understand if these entrepreneurial actions are circumscribed to these situations or have the ability to perpetuate and scale-up afterwards.

5.1.5. Social S-E

Contrary to the less resource-scarce firms, FI developed by resource-scarce actors tend to have social outcomes more often than not. The FI processes in this archetype frequently arise from a personal struggle felt by the entrepreneur or in their close community. These hardships can arise from the non-fulfillment of basic needs such as water or energy, decent working conditions, hygiene or health. Examples include FIs developed by local entrepreneurs and ventures such as the agricultural biomass gasifier, the milking machine, or the cotton deshelling machine (Hossain and Sarkar, 2021; Pansera and Sarkar, 2016). Many of the observed cases enable the creation of jobs, empowerment, and fulfillment of the population's basic needs and offer some sustain environmental benefits, such as those involving renewable sources of energy.

5.1.6. Commercial S-E

It is also possible for resource-scarce ventures to thrive and build a profitable business based on FI, as it is the case for Mitticool (clay fridge) and Agooday (Bamboo toothbrush) (Hossain et al., 2021; Kuo, 2017). Still, although FIs from resource-scarce actors to developing countries can be profitable, this commercial motivation and outcome appears secondary to the social outcome (Hossain and Sarkar, 2021), as we have



seen in Section 5.1.5. This is an archetype, where scaling of grassroots initiatives, can lead to more mainstream entrepreneurial ventures.

### 5.1.7. Commercial S-D and social S-D

In this section, we include our findings in the last two archetypes, where the FIs emerge from resource-scarce contexts, to developed countries, either with commercial or social outcomes. We combined these two in the same section since empirical evidence for each is scarce. We hypothesize, however, that this may constitute a trend hitherto underexplored in the FI literature, or that it may become a future trend as resource-scarce actors improve their FI processes and develop products which are adequate for developed markets (see Section 6.1 for future research directions). Indeed, although in our sample, evidence was scarce for these archetypes, we found von Zedtwitz et al. (2015) study to advance a typology of reverse innovation, which includes subtypes where ours may be included, i.e., those innovation which originate from ideas and development in developing countries but are first commercialized in developed country markets.

## 6. Conclusion

### 6.1. Contributions

To move FI research forward, we draw upon evidence-based method for analysis and synthesis, combining integrative and generative approaches. Our integrative and generative structures help explain and present a phenomenological overview of FI. Our study makes at least four contributions. First, we advance the literature, by following empirical evidence of FI, and integrate the accumulated knowledge base available from case study research (Lesner et al., 2018). By systematically organizing, analyzing, and interpreting a set of 95 FI cases contained in 36 studies, we uncover evidence-based knowledge on the multitude of global actors who are developing FI, the characteristics of the settings in which they are being developed and used, the processes involved such as the focus on performance optimization, the importance of collaborative efforts and the enactment in bricolage, and the variety of outcomes of FI ranging from commercial to sustainable contributions, and the establishment of new and inclusive markets. We contribute to theory by depicting the key elements of FI, presented as the *who-why-where-how-what* framework. This enables the construction of a set of structures reflecting a holistic perspective in a single interpretive scheme, contributing to a more comprehensive understanding of FI. We thus address issues of generalizability and context-specificity, which are typically found in case studies. The framework is divided into five main areas of frugal innovation, aligned to answer the following questions: “Who is engaged in FI?”, “Why are people engaging in FI?”, “Where (in the value chain)?”, “How is it done?”, “What is being done?”. We thus also make a case for shared conceptual clarity and a common language (Century and Cassata, 2016) so that researchers engaged in the area of FI can comprehend each other and how their different yet related approaches relate.

Second, by using a qualitative meta-synthesis research design (Habersang et al., 2019; Hoon, 2013; Rauch et al., 2014) and drawing upon a data set of published qualitative case studies, we find that FI converges around 8 archetypes. Moreover, by identifying and synthesizing the evidence into a typology of archetypes, we establish the building blocks for future research to focus on the less investigated elements and explore their interrelationships with the remaining, to further enrich the FI concept. By generating empirically derived archetypes of FI around the dimensions of the actors’ context, target market and FI outcome, we present an overarching nature of the phenomenon. These archetypes will hopefully constitute a “strategic platform” for future directions of research and practice regarding FI (Gatrell and Breslin, 2017). We are now able to identify the more and less common actors, target markets and FI outcomes, which translates the current state of FI, and also allows to identify some emerging areas of interest i.e.

those which were less commonly found in our study. Our framework allows us to achieve “a level of understanding that transcends the results of the individual studies” (Rauch et al., 2014, pp. 334). With our configurations of FI archetypes, we provide a framework for scholars and practitioners alike, which will help future researchers to analyze FI and hopefully be continuously improved as new evidence is uncovered, further enriching the concept.

Third, as the evidence points out, while FI has generally been associated with emerging economies, researchers are now increasingly recognizing that FI also plays a role in developed countries (European Commission, 2016; Lim and Fujimoto, 2019). Our *who-why-where-how-what* framework and the resulting typology should thus help researchers to identify current FI practices occurring in different countries. Hence, from a theoretical perspective, we hope our synthesis can provide a foundation for asking more refined questions, and ultimately contributing to the construction of a more nuanced theory. Namely, answering to new questions may contribute to further enrich our typology of archetypes.

Finally, from a practical point of view, by “taking stock of what we know” (Frese et al., 2014, p. 210) we also intend to stimulate evidence-based entrepreneurship and management strategies. Based on empirical data, we provide notions of how to innovate frugally and which are the main outcomes when doing so, having advantages for both developers and customers. As budgets get increasingly tighter, and organizations realize that it is possible to frugally deliver quality goods and services, practitioners can draw upon our findings for inspiration, to craft frugal practices in their organizations, including in developed economies. Moreover, an important fact to consider is the repudiation of the view that FI implies the use of low-end technologies and poor-quality products. As many examples show, FI is increasingly and successfully involving more sophisticated technologies and business models in their frugal processes.

### 6.2. Limitations and future research

Our study does not come without limitations. By focusing exclusively on empirical studies published on peer-reviewed journal, we may have overlooked other relevant contributions published in books, for instance, which could further deepen FI knowledge. From a methodological perspective, we believe that qualitative meta-synthesis is a very useful and innovative approach to synthesizing a body of qualitative case study data. Our approach in this paper is inspired by a realist position (Bunge, 1996), as eloquently translated into qualitative research by Miles and Huberman (1994) and Maxwell (2012). This position helped us in refining Hoon’s (2013) original landmark contribution. However, researchers have presented different philosophical concerns regarding how to conduct such analyzes (Hoon, 2013; Rauch et al., 2014) since there are distinctive philosophical underpinnings inspiring different practices. Therefore, engaging in a more in-depth debate, particularly about different powerful approaches to qualitative meta-synthesis and the ways in which they can be improved to acquire cumulative knowledge about phenomena, may be over-due (see Habersang and Reihlen, 2018; Thorne et al., 2004).

Regarding our findings, we believe there is space for further improvements specifically on refining our archetypes. Evidence of FI developed by resource-scarce actors aiming mainly at commercial outcome was scarce. As discussed earlier, FI in these contexts usually arise from embedded struggles of the community and although many FIs generate profits, this is generally a secondary goal. We suggest future researchers to uncover cases of such nature so that the typology can acquire greater depth. Our sample included cases of diverse entrepreneurial contexts (resources, venture sizes, etc.), however it lacked representation in two categories of our typology (identified as “Not observed”). We found scant examples of FI which were developed by resource-scarce actors, having developed countries as the target marker. Nevertheless, we have found a few and recent cases where resource-

scarce actors are trying to extend their business to developed markets, which could classify as reverse innovations. We therefore encourage future researchers to focus on this emerging area and explore cases which can be included in those categories, contributing to improve our archetype framework.

The target market of FI is widely defined as underserved consumers. In summary, “the underserved” includes people who are not yet customers since they cannot afford the existing solutions or which their needs and desires or not met by the existent market. Although usually associated with poor people from developing countries, these underserved consumers can also be from developed countries, since there are also poorer communities in these countries. Furthermore, a new set of underserved customers can become a key target for FI, who are not necessarily poor, but are cost-consciousness and are in search of affordable but robust products. Therefore, we call for further research of these later cases, which were more rarely referred in our sample.

Our study opens up new, fruitful and multiple areas of research for entrepreneurship and management scholars more generally. Beside building upon our *who-why-where-how-what* framework and archetypes, we encourage scholars to address the limitations above, which also are pathways for future work. Furthermore, while we focused on FI, there are other management practices in developed countries which share some similarities. For instance, FIs tend to share several characteristics with “lean” innovations, both aiming to work “efficiently with knowledge” to turn it faster into “value” (Sehested and Sonnenberg, 2011; Tiwari and Herstatt, 2014). Both emphasize the creation of value while minimizing waste (Soni and Krishnan, 2014), with the logic of rationalization and downsizing which underpins the concept of lean practices. By including the “resource scarcity” constraint, FI however extends lean innovation to include processes that require creativity and collaboration among multiple partners. The *scarce resource constraint* underpinning FI, finds marginal mention in lean engineering, yet on the other hand is the hallmark for the frugal approach. Thus, future research is encouraged to work on a type of review, or an otology, whereby shared features and distinctiveness of each are studied.

We limited our search scope to articles which explicitly focused on the term “frugal innovation”. However, there are other papers which study cases, where despite this concept not being explicit, the venture process may have involved FI along some dimensions. While of course this is a common problem with many similar studies of a phenomenon, and although some of our sampled articles explicitly refer to FI related concepts, we encourage future researchers to broaden the scope, including terms such as “jugaad”, “grassroots entrepreneurs” and even “bricolage” as these may overlap with FI. Similarly, while we did not deeply explore reverse innovation (e.g Hadengue et al., 2017.; Zhu et al., 2017). In our analysis, we suggest further empirical and conceptual research to be carried out in order to further understand how FIs can evolve to reverse innovations. Moreover, as we find collaboration and knowledge transfer to be important pieces in FI, it would be interesting to explore the possible relationship between FI and open innovation. Also, one could delve into exploring the value brought by the process of use and exchange of scarce resources to innovate for the underserved in

terms of personal utility and social capital.

As we uncovered bricolage an important process involved in FI, and since these concepts have often appeared isolated from one another in extant literature, we strongly encourage researchers to delve deep into the interplay of FI and bricolage. Bricolage has previously shown to be an effective way to adequately innovate for the BOP consumers while having a positive effect on firm performance (Zhu et al., 2019). Thus, for instance, we can study when does FI involve bricolage, and when does it not.

It seems that resource-abundant actors may start to engage more in frugal processes with the increasing cost-consciousness of the society and the search for cheaper and effective products. Like so, we suggest a new stream of research to look for and aggregate empirical evidence of this tendency, which would be is an important contribution to further develop typology of archetypes and inform researchers and practitioners on the endless possibilities of these types of innovation processes.

Another great area for future research regards the theoretical underpinnings behind FI. It was not our objective to indulge into this discussion in the present study as were focused on empirical evidence-based research. We have indeed observed that the articles from our sample lacked a theoretical perspective to support the empirical data, with a few exceptions such as Devi and Kumar (2018) (actor–network theory); Sharmelly and Ray (2018) (institutional theory) and Agarwal et al. (2021) (theory of constraints). This theory lacking is not characteristic of our sample per se but of the FI literature in general. We consider it could be helpful to conduct a study focused on the analysis and comparison of studies which indeed resort to specific theories and understand how these talk to each other around the FI construct in order to clarify and enrich it from a theoretical perspective. A recent study (Dabić et al., 2022) has made an effort to address this topic, which could make it a good starting point to delve into this type of analysis.

**Acknowledgments**

Soumodip Sarkar gratefully acknowledges generic financial support received from the Fundação para Ciência e Tecnologia (FCT), through UIDB/04007/2020. The authors are grateful to three anonymous reviewers for their very insightful suggestions, that greatly benefitted this paper.

**CRedit authorship contribution statement**

**Soumodip Sarkar:** Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing, Supervision, Validation, Visualization.  
**Sara Mateus:** Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing, Validation, Visualization.

**Declaration of Competing Interest**

None.

**Appendix A – Meta-synthesis method overview**

Step	Strategy	Outcome
Framing the research question	We aim to identify a clear research question which was inspired by the increasing interest of researchers on FI and the still fragmented state of the field. After scanning the literature on FI we felt there was a gap in bringing together all the FI dimensions in one study and understanding its interrelationships, based on empirical evidence.	We framed the research question as “What are the key dimensions involved in FI and how do they interrelate?”
Locating relevant research	As we intend to have a complete and high-quality sample possible, we focused our search with the keyword “frugal innov*” in the Social Sciences Citation Index of the Web of Science database which we further complemented by cross-checking	We located a sample of 160 articles

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Step	Strategy	Outcome
Inclusion criteria	the results list with the articles referenced in reviews on FI and Google Scholar searches We developed specific inclusion/exclusion criteria to evaluate the articles in terms of (1) quality; (2) research focus (3) method and (4) detail of empirical data presented	The initial sample was reduced to 36 articles which were incorporated in the meta-synthesis
Extracting and coding data	We read the full text of each article and structured coding of details such as research question/objectives; methodology (sample size; sampling and data collection strategy); setting (cases identification; country; type of venture); key findings; main contributions; limitations and future research.	The evidence from each article was coded and organized, allowing to have an overview of the sample
Analyzing on a case-specific level	We coded in a line-by-line manner using an inductive and open coding strategy to identify relevant data (concepts, variables) which could contribute to answer the research question.	Identification of themes related with possible FI dimensions
Synthesizing on an across-study level	We proceeded to a cross-case and comparative analysis of the information previously analyzed and identified common themes which would become first-order concepts. These were subsequently combined into second-order themes and then higher dimensions, which would become the FI dimensions.	Identification of patterns among different studies
Building theory from meta-synthesis	From the FI dimensions identified we were able to construct the FI <i>who-why-where-how-what</i> framework which gives an holistic view of the concept by answering. As we found that the answers to these questions can be varied, we built a typology of archetypes so we could further structure and advance on the on conceptualization of FI.	Two different frameworks which organize the available empirical evidence of FI and inform research of understudied areas for future work and theory building
Discussing	We offer a discussion of our findings along with the identification of limitations of our study and provide a future research agenda	Providing of a discussion which validates the findings and identifies weaknesses and future work

## Appendix B – Cases' details

Product / Service	Actor	Actors' country	Product / Service cases		Type of venture	Area	Studies (#)
			Subsidiary (if applicable)	Initial target market			
Basic weighing scale	Mettler Toledo	Switzerland	China	Worldwide	MNC (+ subsidiary)	Other	1
Portable ultrasound machine	General Electric Healthcare	USA	China	China	MNC (+ subsidiary)	Healthcare	1;2;8
Computer mouse	Logitech	Switzerland	China	China	MNC (+ subsidiary)	Computer device	1
Bedside patient monitoring system	Philips	Netherlands	China	Emerging markets	MNC (+ subsidiary)	Healthcare	1
Computed tomography scanner	Siemens	Germany	China	Emerging markets	MNC (+ subsidiary)	Healthcare	1;12
Biogas plant	Grameen Shatki	Bangladesh	–	Bangladesh	Grassroots entrepreneurs / Local firm	Energy	5;19
Sanitary pad machine	A Muruganatham / Jayaashree Industries	India	–	India	Grassroots entrepreneurs / Local firm	Hygiene	5;17;18;19;20
Cotton deshelling machine	Mansukhbhai Patel / Chetak Industries	India	–	India	Grassroots entrepreneurs / Local firm	Agriculture	5; 19
Agricultural Biomass Gasifier	Raj Singh Dahiya	India	–	India	Grassroots entrepreneurs	Energy	5
Portable ECG machine	–	India	–	India	EMNC	Healthcare	8
Pre-screening device for blindness	–	India	–	India	Local firm	Healthcare	8
Portable device for infectious diseases detection	–	Netherlands	–	China and other developing countries	MNC	Healthcare	8
Device for infectious diseases detection	–	India	–	India	Local Firm	Healthcare	8
Portable fridge	Godrej	India	–	India	EMNC	Appliances	2;7
Tata Nano car	Tata	India	–	India	EMNC	Transports	2
Solar powered ATM	Vortex Engineering	India	–	India	Local firm	Bank services	2;12
Solar system	Selco	India	–	India	Social enterprise	Energy	4;11;19
Water purification device	Tata Chemicals	India	–	–	EMNC	Water	4
Biomass gasifier	Husk Power Systems	India	–	India	Local firm	Energy	4
Water purifier	Hindustan Unilever	UK/ Netherlands (Unilever)	India	–	MNC (+ subsidiary)	Water	4
Water filter	Aalto University and Ahlstrom	Finland	–	Tanzania	University + MNC	Water	3
Clay fridge	Mansukhbhai Prajapati / MittiCool	India	–	India	Grassroots entrepreneurs / Local firm	Appliances	18; 19; 20

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Product / Service	Actor	Actors' country	Product / Service cases		Type of venture	Area	Studies (#)	
			Subsidiary (if applicable)	Initial target market				
Milking machine	Raghava Gowda / Ksheera Enterprise	India	–	India	Local firm	Grassroots entrepreneurs	Food	18; 19; 20
Solar light bulb	MyShelter Foundation	Philippines	–	Philippines	NPO		Energy	7;15
Solar cooker	New Energy Research and Demonstration center	China	–	China	Government agency		Appliances	7
Bamboo toothbrush	Agooday	Taiwan	–	Taiwan	Grassroots entrepreneurs / Social enterprise		Hygiene product	7
Human milk pasteurizer	Hospital de Tacuarembó + Nutríssima	Uruguay	–	The hospital itself	Hospital + Local firm		Healthcare	6
Neuronavigator	Hospital de Tacuarembó + Universidad de la República	Uruguay	–	The hospital itself	Hospital + University		Healthcare	6
Valves for ventilator	Isinnova	Italia	–	Italia	Start-up		Healthcare	16;23
Face shield	Maker's Asylum	India	–		Makerspace		Healthcare	16
Equipment for waste picker	Unisul + 65 etallurgical industry	Brazil	–	Brazil	University + industry		Waste management	10
WWTP	Cplantae	Mexico	–	Mexico	Social Enterprise		Water	13
Rainwater harvesting system	NETA CERO	Mexico	–	Mexico and Latin America	Social Enterprise		Water	13
Solar-electric rickshaw	Central Mechanical Engineering Research Institute (CMERI)	India	–	India	Research Institute		Transports	11
Electric delivery car	RWTH Aachen University + Deutsche Post (StreetScooter)	Germany	–	Germany	University + MNC		Transports	11
Solar system	M-Kopa	Kenya	–	Kenya and neighboring countries	Social Enterprise		Energy	11
Portable ECG machine	General Electric Healthcare	USA	–	India	MNC		Healthcare	12
Hyundai Eon car	Hyundai India	South Korea	India	India	MNC (subsidiary)		Transports	9
Firefighter cooling vest	University of Technology Sydney + not identified company	Australia	–	Australia	University + Local firm		Other	24
Software for stable internet connection	–	France	–	Algeria, Tanzania, Ivory Coast, Senegal	Start-up		Software	22
Stove	–	Kenya	–	Kenya, Ruanda & Uganda	Local Firm		Appliances	22
PET bottles to be used for construction	–	South Africa	–	South Africa	NPO		Waste management	22
Solar tools	–	Finland	–	Kenya, Tanzania	Social Enterprise		Energy	22
3D printed prosthetic limbs	–	USA	–	South Sudan	NPO		Healthcare	22
Pedal generator	–	USA	–	Rwanda, Kenya, Burundi	MNC		Energy	22
Laptops for students	–	USA	–	Rwanda, Ethiopia	NPO		Education	22
Eyeglasses	–	Germany	–	Malawi, Uganda, Burkina Faso	NPO		Healthcare	22
Micro-biogas plant	–	Germany	–	Kenya	MNC		Energy	22
Solar powered kiosk shop	–	Germany	–	Ghana, Rwanda, Somaliland	MNC		Energy	22
Portable slow cooker	–	South Africa	–	South Africa, Ghana, Somalia, Kenya, etc.	Social Enterprise		Appliances	22
Medical device to detect breast cancer	UE LifeSciences	USA-Indian	–	India	MNC		Healthcare	14
Baby incubator	–	USA	–	India	MNC		Healthcare	14
Torque limiter	–	USA	German, UK, Austria	Developed countries	MNC		Other	25
The movie "Lucia"	Pawan Kumar	India	–	–	Grassroots Entrepreneurs		Other	21
Bamboo splint making machine	–	India	–	India	Grassroots entrepreneurs		Agriculture	19
Cotton wick making machine	Vijaybhai Solanki	India	–	India	Grassroots entrepreneurs		Agriculture	19
Baby incubator	Embrace	USA	–	Developing countries	Social enterprise		Healthcare	15;19
Baby incubator	mOm	UK	–	Developed countries	Social enterprise		Healthcare	19
Energy-related products	Bright Green energy	Bangladesh	–	Bangladesh	Social enterprise		Energy	19
Solar energy solutions	Boond	India	–	India	Social enterprise		Energy	19
	Nuru Energy	Canada	–	Africa and India	Social enterprise		Energy	19

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Product / Service	Actor	Actors' country	Product / Service cases		Type of venture	Area	Studies (#)
			Subsidiary (if applicable)	Initial target market			
Energy-related products							
Solar photovoltaic microgrids	–	Brazil	–	Brazil	NPO	Energy	13
Solar water heaters	–	Brazil	–	Brazil	NPO	Energy	13
Artificial limbs	Jaipur Foot	India	–	India	Social enterprise	Healthcare	15
Refrigerator	Pot in pot	Nigeria	–	Nigeria	Social enterprise	Appliances	15
Venture cases							
	<b>Actor</b>	<b>Actors' country</b>	<b>Subsidiary (if applicable)</b>	<b>Initial target market</b>	<b>Type of venture</b>	<b>Area</b>	<b>Studies (#)</b>
	Narayana Hrudayalaya	India	–	India	Hospital	Healthcare	12;27
	Gettinge Group	Sweden	–	Southern Africa and southeast Asia	MNC	Healthcare	26
	–	India	–	–	EMNC	Consumer products	29
	–	India	–	–	EMNC	Biotechnology	29
	–	India	–	–	EMNC	Consumer products	29
	–	India	–	–	EMNC	Metalworks	29
	–	India	–	–	EMNC	Multisector	29
	–	India	–	–	EMNC	Metalworks	29
	–	India	–	–	EMNC	Consumer products	29
	–	India	–	–	EMNC	Multisector	29
	–	Brazil	–	Brazil	Local Firm	Transports	31
	–	Brazil	–	Brazil	Local Firm	Cosmetics	31
	–	Brazil	–	Brazil	Local Firm	Energy	31
	–	Germany	Brazil	Brazil	MNC	Energy	31
	–	USA	Brazil	Brazil	MNC	Transports	31
	–	Germany	Brazil	Asia, Africa, and South America	MNC	Appliances	31
	University of Campinas	Brazil	–	–	University	Other	32
	MedicallHome	Mexico	–	Mexico	Health program	Healthcare	27
	BasicNeeds	Kenya	–	Africa and Asia	Health program	Healthcare	27
	Family Health Strategy	Brazil	–	Brazil	Health program	Healthcare	27
	GeriCare@North	Singapore	–	Singapore	Health program	Healthcare	27
	SainAngelo	China	–	China	Local firm	Textile	28
	Shifeng	China	–	China	Local Firm	Transports	30
	Bayoa	China	–	China	Local firm	Transports	30
	Taiqi	China	–	China	Local firm	Transports	30
City / country cases							
<b>Context</b>		<b>City / country</b>				<b>Area</b>	<b>Studies (#)</b>
Bamboo Shoot Processing		Manipur, India				Agriculture	34
Mobile money		Kitwe, Zambia				Bank services	35
Tackling COVID-19		Kerala, India				Other	36
Water filters		India				Water	33
Solar water heaters		São Paulo, Brazil				Energy	13

(1) (-) indicates that the information does not apply to the case or that it was not available

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